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(54) **IMAGING SYSTEM, WRITING HEAD, AND IMAGE FORMING APPARATUS**

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(52) **U.S. Cl.**

CPC ***B41J 2/451*** (2013.01)

(58) **Field of Classification Search**

CPC B41J 2/47; B41J 2/451; B41J 2/471; H04N 1/1135

See application file for complete search history.

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(57) **ABSTRACT**

An imaging system includes incidence faces composed of optical faces having an image focusing function; prisms; and exit faces. The incidence faces are arranged with a first pitch along a first axial direction. The prisms are arranged with a second pitch along the first axial direction. The exit faces are arranged with a third pitch along the first axial direction. The first axial direction is set as a Y direction. A normal line direction of a face top of an optical face of the incidence face in a plane perpendicular to the first axial direction is set as a X direction. A direction perpendicular to the Y direction and the X direction is set as a Z direction. In a XZ cross-section plane, a width of the prism in the Z direction is smaller than a width of optical face of the incidence face in the Z direction.

13 Claims, 12 Drawing Sheets

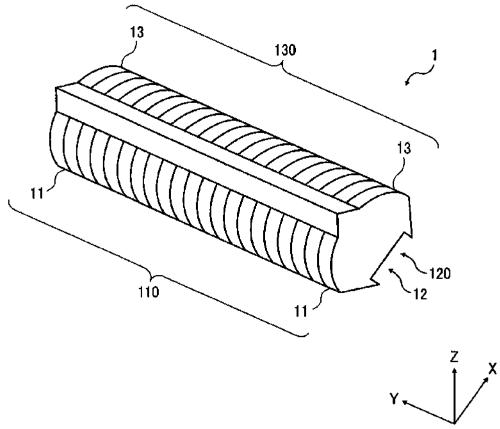

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FIG. 1

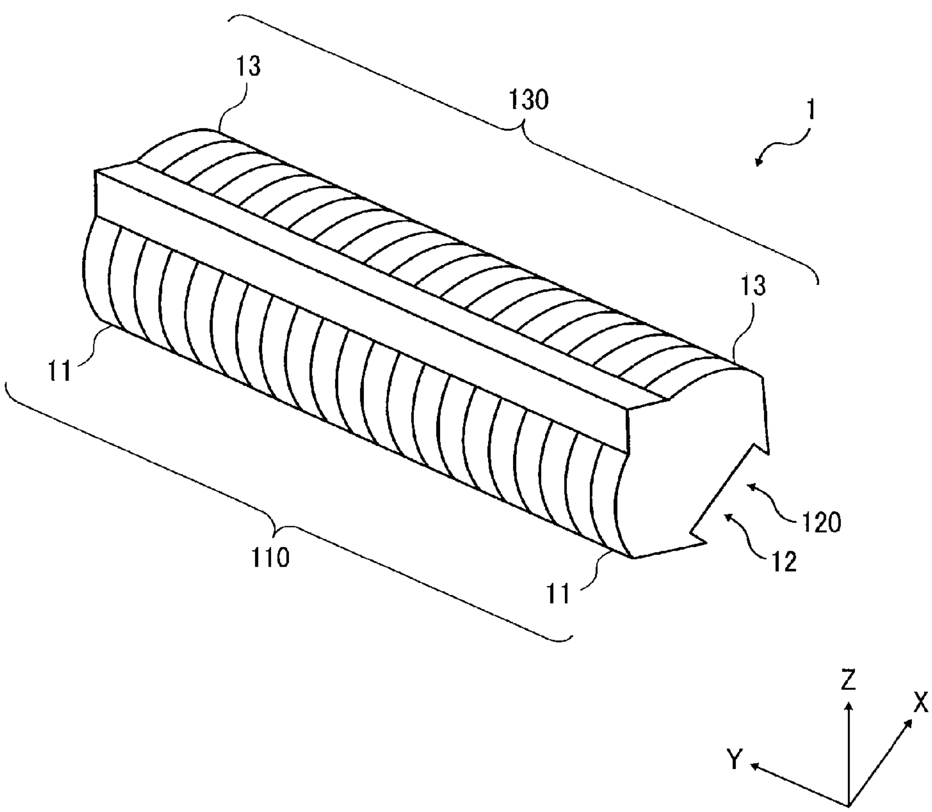


FIG. 2

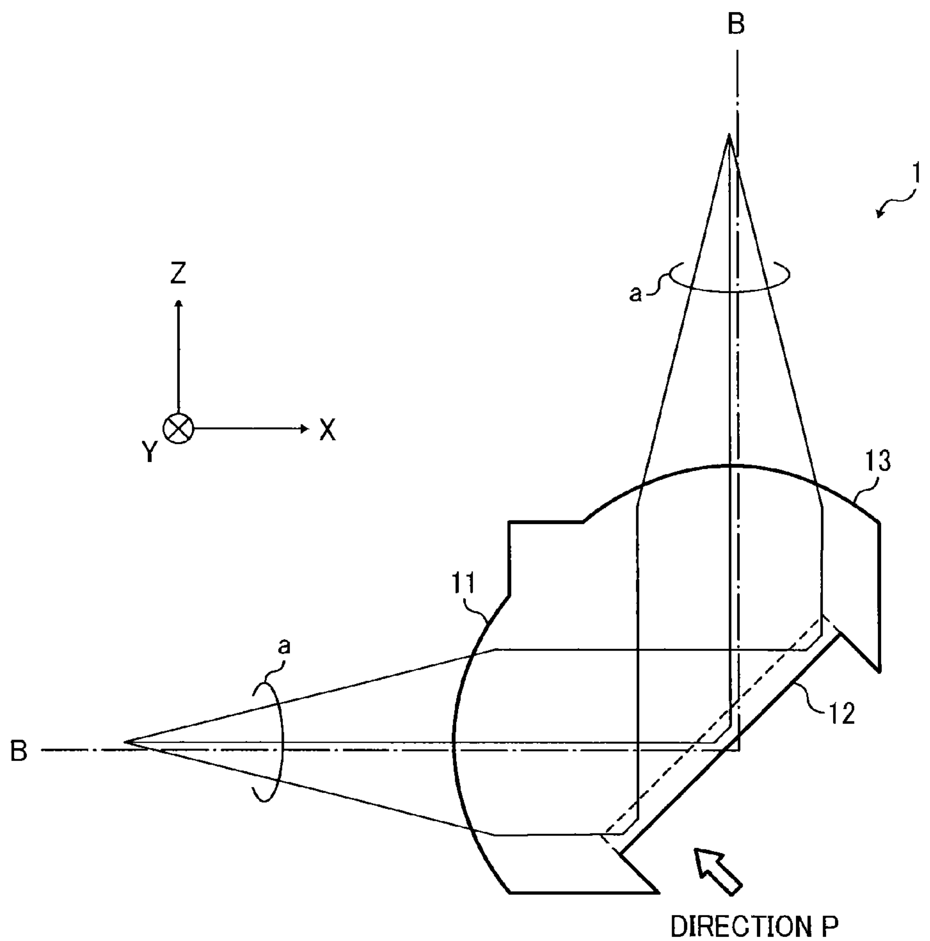


FIG. 3

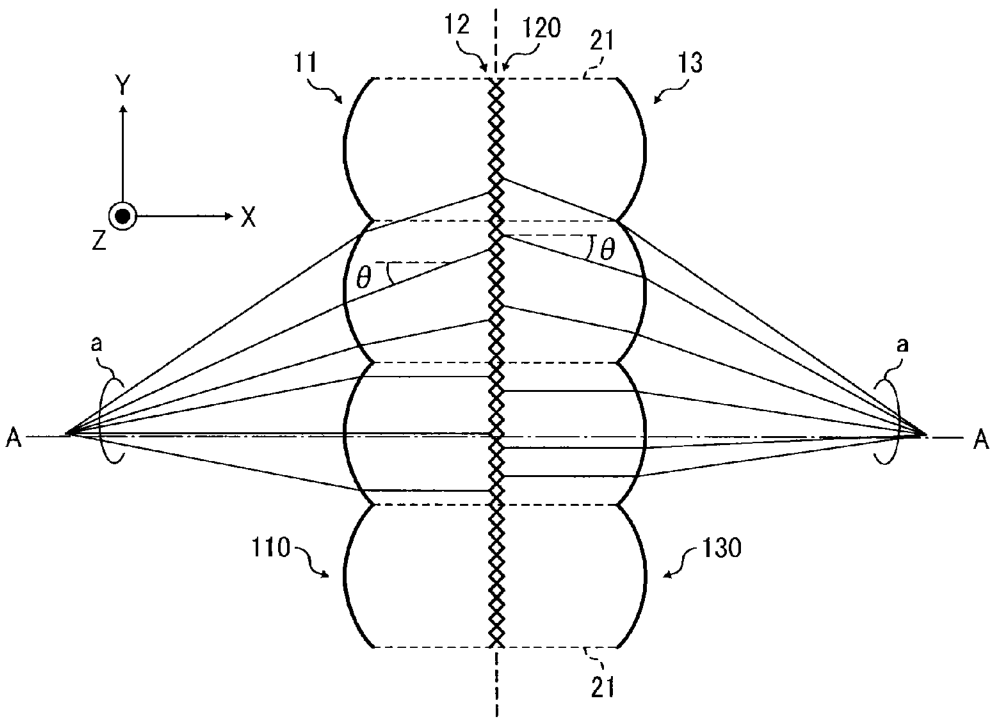


FIG. 4

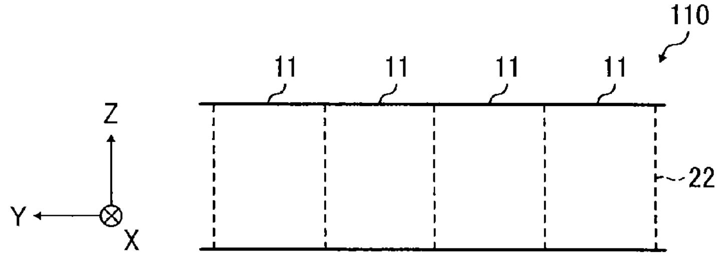


FIG. 5A

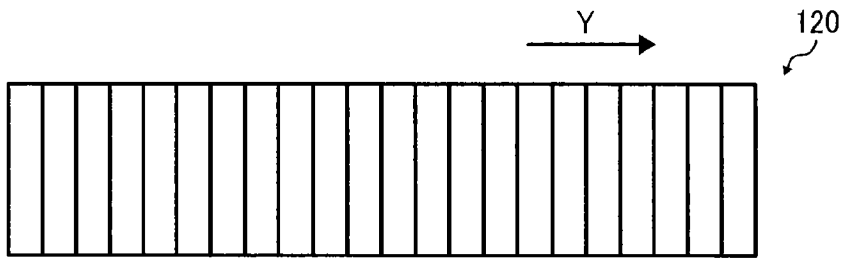


FIG. 5B

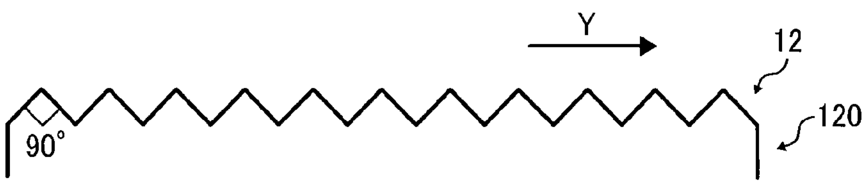


FIG. 6A
RELATED ART

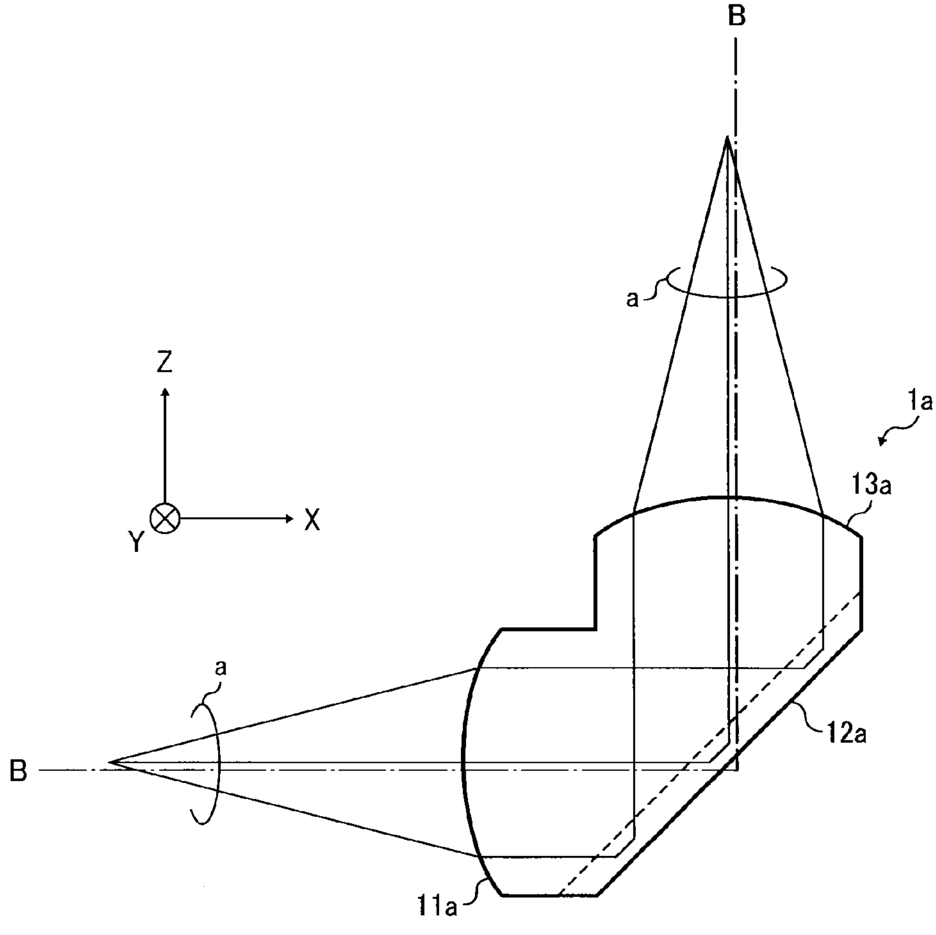


FIG. 6B
RELATED ART

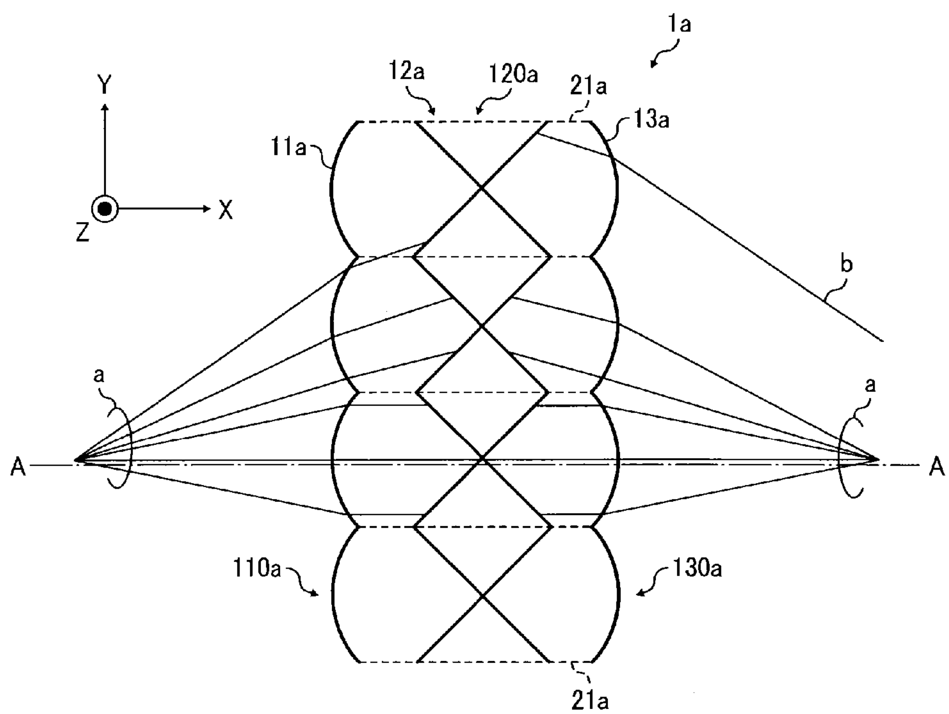


FIG. 7

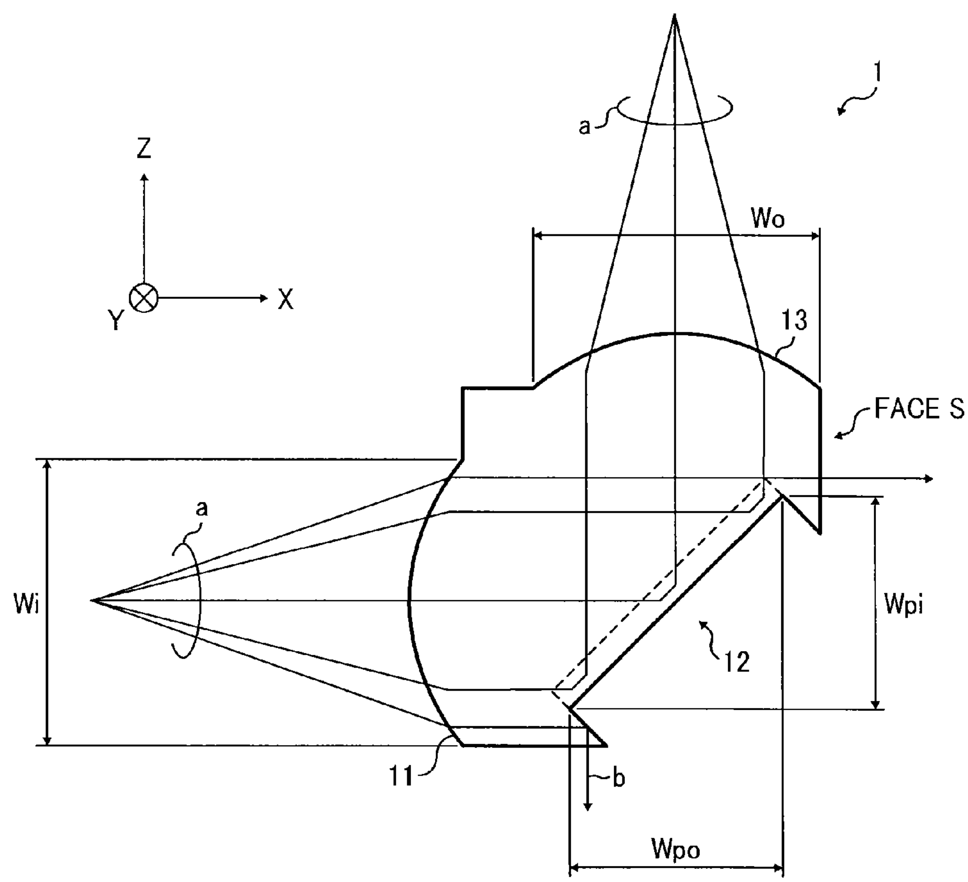


FIG. 8

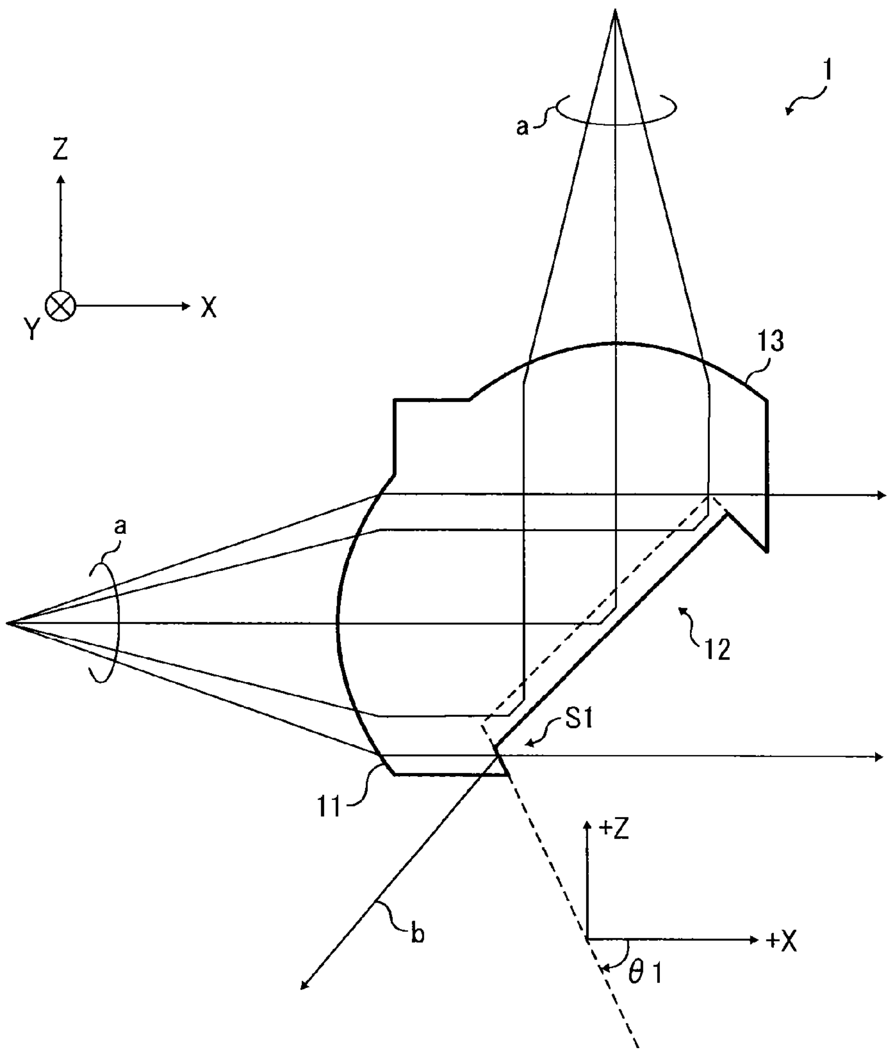


FIG. 9

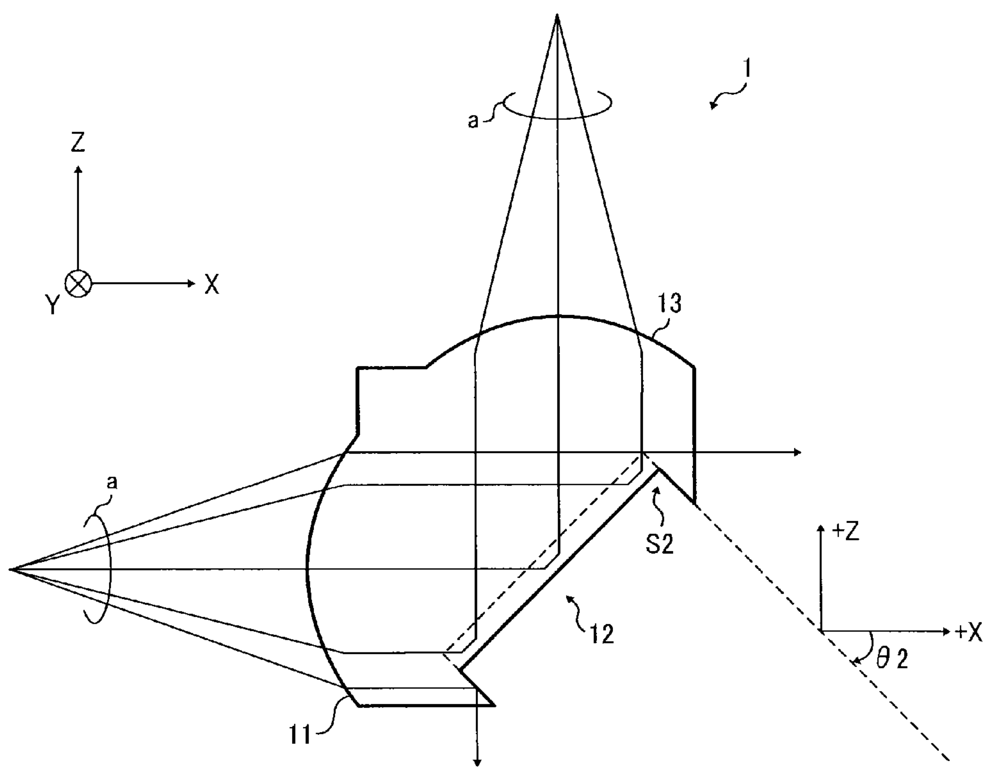


FIG. 10

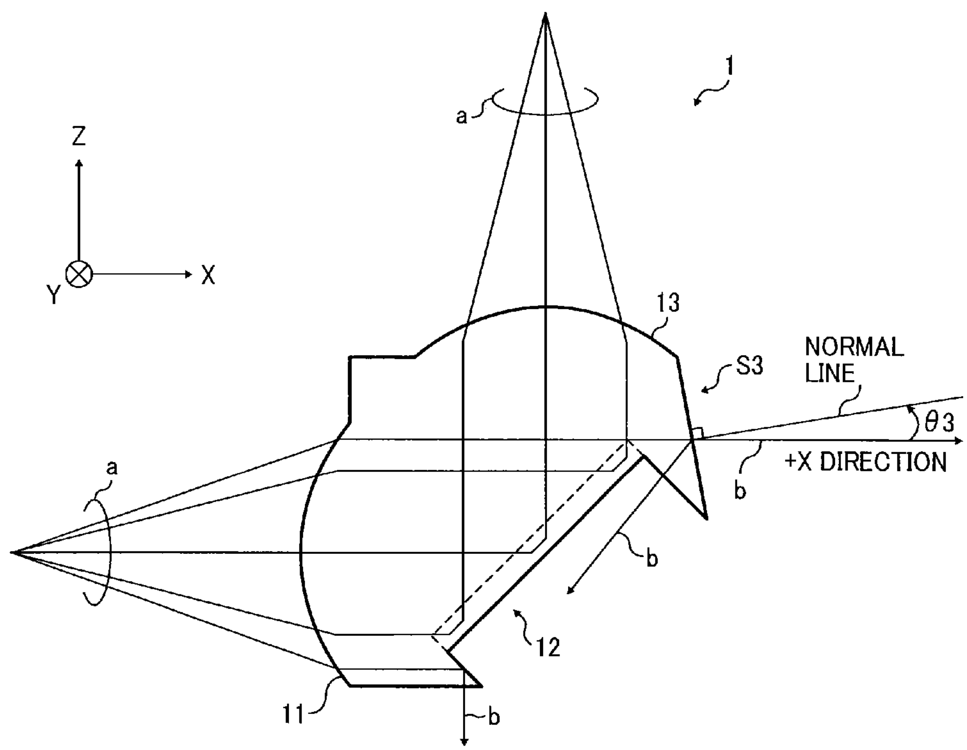


FIG. 11

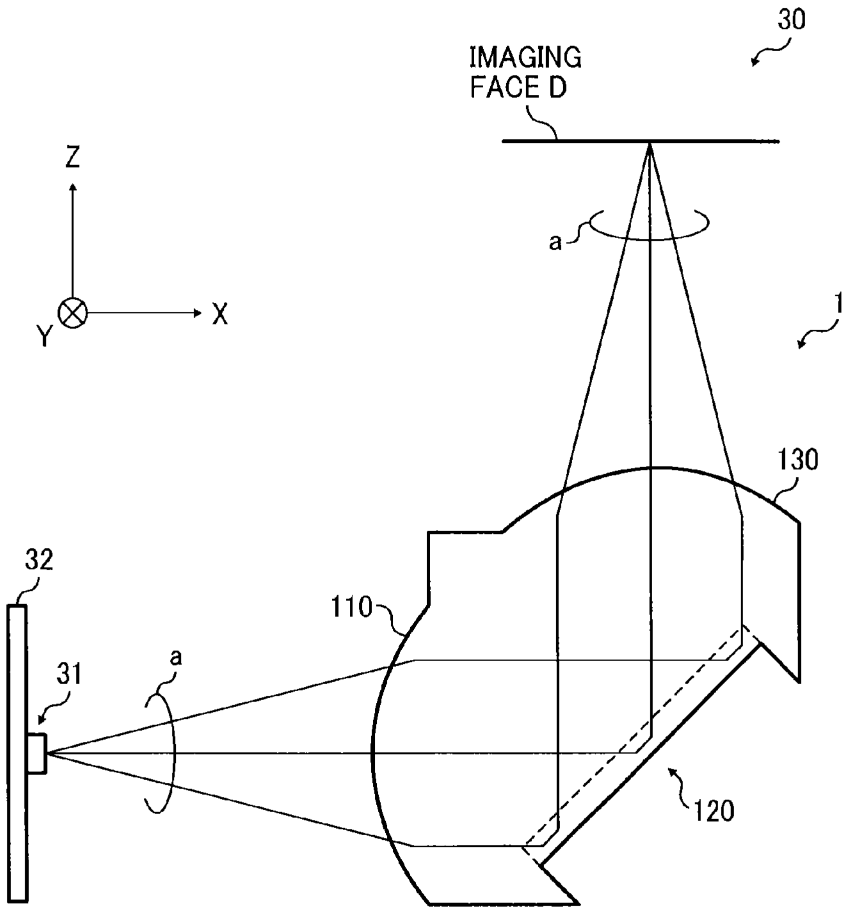
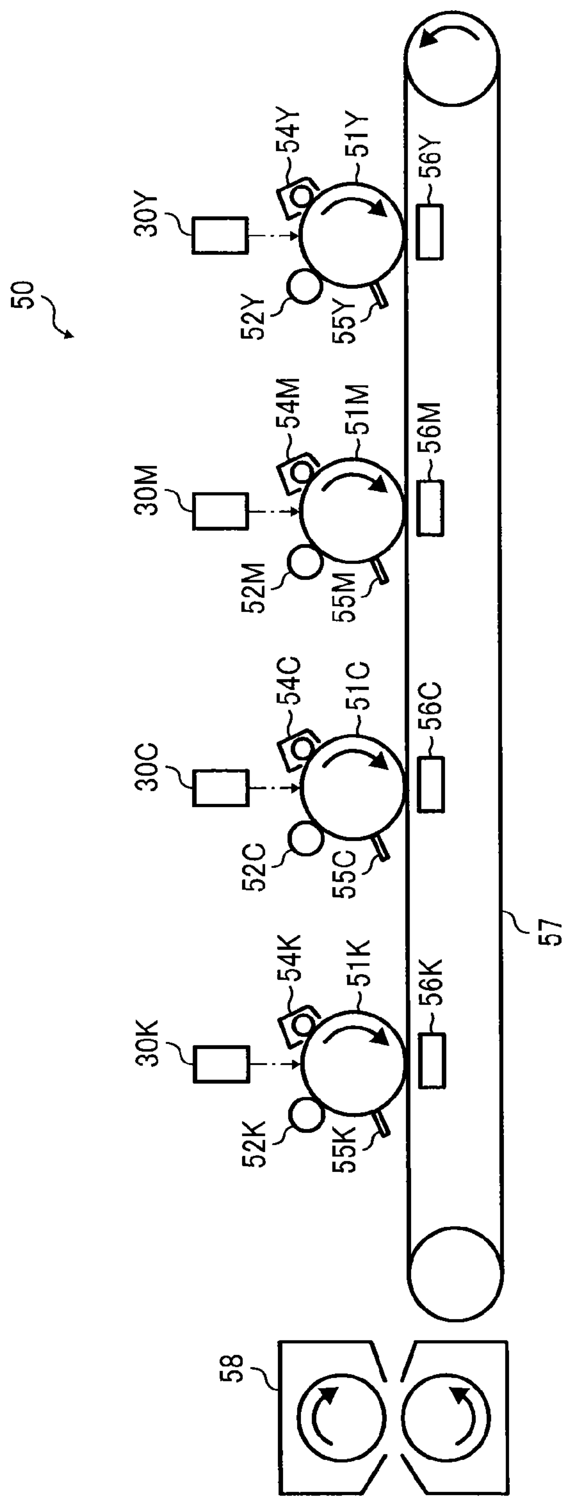


FIG. 12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IMAGING SYSTEM, WRITING HEAD, AND IMAGE FORMING APPARATUS

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority pursuant to 35 U.S.C. §119 to Japanese Patent Application No. 2013-050431, filed on Mar. 13, 2013 in the Japan Patent Office, the disclosures of which is incorporated by reference herein in their entirety.

BACKGROUND

1. Technical Field

The present invention relates to an imaging system, a writing head and an image forming apparatus.

2. Background Art

Exposing devices used for image forming apparatuses such as laser printers and copiers include a writing head configured with a light source such as light emitting diode (LED) array and an organic electroluminescence (OEL) array, and a lens array. The lens array of the writing head may employ a gradient index lens array, but light use efficiency of the gradient index lens array may not be sufficient. Therefore, the gradient index lens array may not be employed for high speed apparatuses. Especially, if the OEL is used as the light source, because light quantity of the OEL is smaller than light quantity of the LED, an optical system to enhance light use efficiency is required.

To enhance the light use efficiency of the writing head, an imaging system configured with a lens and a roof prism or with a lens and a roof mirror can be used. In such imaging system, a plurality of optical systems are arranged in a main scanning direction, and the lens array pitch is same as the roof prism array pitch or the roof mirror array pitch. Therefore, this imaging system has a retroreflective optical system that reflects an image for two times in a main scanning direction using the roof prism and the roof mirror, and an "upright image" can be generated in the main scanning direction, and an "inverted image" can be generated in a sub-scanning direction.

In the above described imaging system, if some of the light is focused at a position on an imaging face that should not be focused, ghost light may occur. The ghost light can be suppressed by disposing a slit at the lens array side.

The ghost light can be reduced using the slit having an light absorbing effect, but the light use efficiency becomes lower due to the light absorbing by the slit.

Further, an aperture can be disposed at the incidence face side of the imaging system to suppress light propagation to undesired positions. However, it is very difficult to manufacture an aperture array matched to each incidence face of the imaging system with high precision. Therefore, the aperture may not be practical for preventing occurrence of ghost light.

Further, an aperture can be disposed at the exit face side of the imaging system to suppress occurrence of ghost light. The aperture disposed at the exit face side of the imaging system can be a single aperture, but the single aperture becomes a long aperture in a long side direction of the imaging system. Such long aperture is difficult to manufacture, and strength of the aperture becomes weak, and resultantly the aperture becomes weak to vibration. Therefore, mechanical strength of the imaging system becomes lower.

Further, the number of parts increases when the aperture is disposed as above described. Further, a correct positioning between the aperture and the optical face of the imaging system is required, which increases cost of the imaging system.

SUMMARY

In one aspect of the present invention, an imaging system is devised. The imaging system includes a plurality of incidence faces composed of a plurality of optical faces having an image focusing function; a plurality of prisms; and a plurality of exit faces. The plurality of incidence faces is arranged with a first pitch along a first axial direction. The plurality of prisms is arranged with a second pitch along the first axial direction. The plurality of the exit faces is arranged with a third pitch along the first axial direction. The first axial direction is set as a Y direction. A normal line direction of a face top of an optical face of the incidence face in a plane perpendicular to the first axial direction is set as a X direction. A direction perpendicular to the Y direction and the X direction is set as a Z direction. In a XZ cross-section plane, a width of the prism in the Z direction is smaller than a width of optical face of the incidence face in the Z direction.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete appreciation of the disclosure and many of the attendant advantages and features thereof can be readily obtained and understood from the following detailed description with reference to the accompanying drawings, wherein:

FIG. **1** is a schematic perspective view of an imaging system according to an example embodiment;

FIG. **2** is a schematic cross-sectional view of the imaging system of FIG. **1** viewed from a short side direction, in which a light path is shown;

FIG. **3** is a schematic cross-sectional view of the imaging system of FIG. **1** viewed from a long side direction, in which a light path is shown;

FIG. **4** is a schematic view of an optical face of the imaging system of FIG. **1** viewed from a light source side;

FIG. **5**A is a schematic view of a prism array viewed from a direction perpendicular to an arrangement face;

FIG. **5**B is a schematic cross-sectional view of a prism array along a long side direction;

FIGS. **6**A and **6**B are schematic cross-sectional view of conventional imaging system showing a light path;

FIG. **7** is a schematic cross-sectional view of an imaging system according to another example embodiment viewed from a short side direction, in which a light path is shown;

FIG. **8** is a schematic cross-sectional view of an imaging system according to still another example embodiment viewed from a short side direction, in which a light path is shown;

FIG. **9** is a schematic cross-sectional view of an imaging system according to still another example embodiment viewed from a short side direction, in which a light path is shown;

FIG. **10** is a schematic cross-sectional view of an imaging system according to still another example embodiment viewed from a short side direction, in which a light path is shown;

FIG. **11** is a schematic cross-sectional view of a writing head according to an example embodiment viewed from a short side direction, in which a light path is shown; and

FIG. **12** is a schematic configuration of an image forming apparatus according to an example embodiment.

The accompanying drawings are intended to depict exemplary embodiments of the present invention and should not be interpreted to limit the scope thereof. The accompanying drawings are not to be considered as drawn to scale unless explicitly noted, and identical or similar reference numerals designate identical or similar components throughout the several views.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

A description is now given of exemplary embodiments of the present invention. It should be noted that although such terms as first, second, etc. may be used herein to describe various elements, components, regions, layers and/or sections, it should be understood that such elements, components, regions, layers and/or sections are not limited thereby because such terms are relative, that is, used only to distinguish one element, component, region, layer or section from another region, layer or section. Thus, for example, a first element, component, region, layer or section discussed below could be termed a second element, component, region, layer or section without departing from the teachings of the present invention.

In addition, it should be noted that the terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the present invention. Thus, for example, as used herein, the singular forms “a”, “an” and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise. Moreover, the terms “includes” and/or “including”, when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

Furthermore, although in describing views shown in the drawings, specific terminology is employed for the sake of clarity, the present disclosure is not limited to the specific terminology so selected and it is to be understood that each specific element includes all technical equivalents that have the same function, operate in a similar manner, and achieve a similar result.

Referring now to the drawings, a description is given of an apparatus or system for an image projection apparatus such as a projector according to an example embodiment.

A description is given of an imaging system, a writing head, and an image forming apparatus according to an example embodiment with reference to the drawings.

First Example Embodiment of Imaging System

FIG. **1** is a schematic perspective view of a roof prism lens array (RPLA) **1** of an imaging system according to a first example embodiment. The RPLA **1** includes, for example, an incidence face array **110**, a prism array **120** and an exit face array **130**. The incidence face array **110** includes a plurality of incidence faces **11** having image focusing function. The prism array **120** includes a plurality of prisms **12** disposed on a light path from the incidence face **11**.

The exit face array **130** includes a plurality of exit faces **13** having image focusing function disposed on a light path from the prism **12**.

As shown in FIG. **1**, in the RPLA **1**, each of the incidence face **11**, the prism **12** and the exit face **13** are arranged in one dimensional direction while facing with each other. The one dimensional direction, which is an arrangement direction of each of the incidence face **11**, the prism **12** and the exit face **13** or a long side direction, is referred to as Y direction. Further, an axis along the Y direction is referred to as Y axis or a first axis.

Further, as shown in FIG. **1**, a normal direction extending from a face top of an optical face (i.e., incidence face **11**) of the incidence face array **110** toward the prism **12** is referred to as X direction, and an axis along the X direction is referred to as X axis. Further, a direction perpendicular to the Y direction and the X direction is set as Z direction, and an axis along the Z direction is referred to as Z axis.

The light beam “a” that has entered the RPLA **1** from the incidence face **11** proceeds along the X direction. Then, the light beam “a” is reflected at the prism **12**, and then proceeds along the Z direction. Then, the light beam “a” exits from the exit face **13**.

Specifically, the light beam “a” emitted from each one of point light sources, disposed at the incidence face **11** side, enters corresponding each one of the incidence faces **11** of the incidence face array **110**. The light beam “a” is reflected by corresponding each one of the prisms **12**, and exits from corresponding each one of the exit faces **13** of the exit face array **130**. Therefore, the prism array **120** is disposed after the incidence face array **110** to direct the light beam “a” to the exit face array **130**, wherein the prism array **120** is angled 45 degrees with respect to a direction perpendicular to the arrangement direction of the incidence face **11**. Further, an apex angle of the prism array **120** is, for example, 90 degrees to be described later.

The exit face array **130** is angled 90 degrees with respect to the direction perpendicular to the arrangement direction of the incidence face **11**. Therefore, the light beam “a” emitted from a given point at the incidence face array **110** side enters the corresponding incidence face **11**, and is reflected by the corresponding prism **12** facing the corresponding incidence face **11**, and then exits from the corresponding exit face **13**.

The RPLA **1** is an optical element, which integrates the incidence face array **110**, the prism array **120** and the exit face array **130** as one element, and the RPLA **1** is made of, for example, resin by using a molding method.

A description is given of the RPLA **1** with reference to FIG. **2**. FIG. **2** is a schematic cross-sectional view of the RPLA **1** of FIG. **1** viewed from a short side direction, in which a light path is shown. FIG. **2** is a schematic XZ cross-sectional view parallel to the XZ-plane passing a face top of an optical face, and FIG. **2** is a schematic cross-sectional view of the RPLA **1** cut at a line A-A in FIG. **3**.

As shown in FIG. **2**, the light beam “a” entering from the incidence face **11** of the RPLA **1** is reflected by the prism **12** along the Z direction by reflecting the light path for 90 degrees to the Z direction, and then exits from the exit face **13**. The light beam “a” exiting from the exit face **13** is focused on a substantially one point on an imaging face as an image.

FIG. **3** schematically shows a light path for the RPLA **1** viewed from a long side direction. FIG. **3** shows a cross-sectional shape parallel to the XY-plane at a left side and a cross-sectional shape parallel to the YZ-plane at a right side while using the prism **12** as the center.

FIG. **3** is a schematic cross-sectional view of a plane parallel to the Y direction while passing the center of each of the incidence face **11**, the prism **12** and the exit face **13**. FIG. **3** is a schematic cross-sectional view of the RPLA **1** cut at a line B-B in FIG. **2**. FIG. **3** is prepared by folding a cross section area from the exit face **13** to the prism **12** for 90 degrees in the X direction, and the cross section area from the exit face **13** to the prism **12** is set parallel to a cross section area from the incidence face **11** to the prism **12**. Further, in FIG. **3**, a virtual plane extending from an end of the incidence face **11** and an end of the corresponding exit face **13** in the Y direction is indicated as a virtual plane **21**.

FIG. **4** is a schematic view of an optical face of the incidence face **11** viewed from a light source side or X direction. In FIG. **4**, a boundary line of adjacent incidence faces **11** is indicated as a boundary line **22**.

FIG. **5**A is a schematic view of a prism array viewed from one direction (direction P in FIG. **2**) perpendicular to an arrangement face of the prism array **120**, and shows ridgelines of mountains and valleys of the prism **12**. FIG. **5**B is a schematic cross-sectional view of the prism array **120** along a long side direction, and the cross-sectional face is parallel to a plane angled 45 degrees with respect to the XY-plane. As shown in FIG. **5**B, an apex angle of each of the prisms **12** composing the prism array **120** is 90 degrees.

As shown in FIGS. **1** and **3**, in the RPLA **1**, a plurality of the incidence faces **11** is arranged along the first axial direction with a first pitch, and a plurality of the exit faces **13** is arranged along the first axial direction with a third pitch. The first pitch and the third pitch are the same pitch. Further, a plurality of the prisms **12** is arranged along the first axial direction with a second pitch. The second pitch is set shorter than the first pitch and the third pitch. For example, the first pitch of the incidence face **11** and the third pitch of the exit face **13** are set to 0.8 mm, and the second pitch of the prism **12** is set to 0.01 mm.

In the RPLA **1**, the light beam "a" entering from the incidence face **11** reflects totally two times at the prism **12** of the prism array **120**. Therefore, in the Y direction, the light beam "a" entering from one incidence face **11** exits to one corresponding exit face **13** with an exit angle, which is same as an incidence angle to the prism **12**. The incidence angle to the prism **12** and the exit angle from the prism **12** are referred to as an angle θ.

As shown in FIG. **3**, the RPLA **1** is a retroreflective optical system. With this configuration, the RPLA **1** can form an upright image along the arrangement direction. Therefore, the light beam "a" coming from one point on an object passes a plurality of the incidence faces **11** and is then focused at a substantially one point. Because the RPLA **1** is the retroreflective optical system in the Y direction, a brighter image can be formed.

Further, as shown in FIG. **2**, in the XZ-plane of the RPLA **1**, the light beam "a" entering from the incidence face **11** is totally reflected on the prism **12** and exits from the exit face **13** by bending the light path for 90 degrees, which means the RPLA **1** focuses an image at two faces such as the incidence face **11** and the exit face **13** in the XZ-plane. Therefore, the RPLA **1** forms an inverted image in a direction perpendicular to the arrangement direction.

A description is given of an effect of the RPLA **1**. FIG. **6** is a schematic cross-sectional view of a RPLA **1***a* of conventional imaging system. FIG. **6**A is a schematic cross-sectional view of the RPLA **1***a* in the short side direction, in which a light path is shown as similar to FIG. **2**. FIG. **6**B is a schematic cross-sectional view of the RPLA **1***a* viewed from the long side direction, in which a light path is shown as similar to FIG. **3**.

As shown in FIG. **6**B, when the pitch of the prism **12***a* is set same as the pitch of the incidence face **11***a* and the pitch of the exit face **13***a*, the light beam "a" passing through the virtual plane **21***a* extending from an end of the incidence face **11***a* and an end of the exit face **13***a* in the arrangement direction may not be focused on a desired position on an imaging face as indicated by light beam "b" in FIG. **6**B. The light beam "b" not focused on the imaging face becomes ghost light.

Therefore, if the pitch of the prism **12***a* is set same as the pitch of the incidence face **11***a* and the pitch of the exit face **13***a*, a position of the light beam "a" on a prism lens array **120***a* in the Y direction may deviate, in which the light beam "b" passing one incidence face **11***a* and one exit face **13***a* that are not a designed pair of the incidence face and the exit face is generated, and the deviated light beam "b" becomes ghost light.

Therefore, as above described for the RPLA **1** of the example embodiment, when the pitch of the prism **12** is set smaller than the pitch of the incidence face **11**, a positional deviation of the light beam "a" that has passed the virtual plane **21**, extending from the end of the incidence face **11** and the end of the corresponding exit face **13** in the Y direction, on the prism array **120** becomes small (see FIG. **3**).

In the RPLA **1**, at the same position in the first axial direction (Y direction), one optical face (incident optical face) in the incidence face **11** and one optical face (exit optical face) in the exit face **13** are paired. The light beam "a" emitted from the point light source enters the incident optical face paired with the exit optical face. Some of the light beam "a" entering the incident optical face passes the virtual plane **21** extending from the end of the incident optical face (incidence face **11**) and the end of the corresponding exit optical face (exit face **13**) in the Y direction, and is then reflected by the prism **12**, and then passes the virtual plane **21** again, and goes to the exit optical face.

In the above described RPLA **1**, the light beam "a" entering from the incidence face **11** and reflected by the prism **12** exits from the exit face **13**, which is a pair of the incidence face **11**, and focused. Therefore, occurrence of ghost light can be prevented. Further, because the light beam "a" can be focused at a desired position, a brighter image can be formed.

Second Example Embodiment of Imaging System

A description is given of an imaging system according to a second example embodiment. Some of the same configuration of above described first example embodiment is applied to the second example embodiment, and the same reference numbers or characters are assigned for the same parts without detail description, and a difference of the second example embodiment is described.

In addition to the above described reasons causing the ghost light to the imaging system, other reasons may cause the ghost light. For example, a relative position error of the incidence face **11**, the prism **12**, and the exit face **13**, and a relative position error of a light source and the RPLA **1** may cause the ghost light. If such error exists, the light beam "a" may reach an imaging face without passing the incidence face **11**, the prism **12** and the exit face **13** in this order. If the light beam "a" not passing through a normal light path reaches the imaging face, the light beam "a" becomes the ghost light.

To prevent the ghost light caused by the above described relative position error, an aperture can be disposed between the light source and the incidence face **11** of the RPLA **1** to block the light beam "a" near the end portion of the incidence face **11** in the Z direction.

However, when the aperture is disposed before the incidence face **11**, the number of parts increases. Further, because the aperture and the incidence face **11** need a correct positioning, manufacturing cost increases. Further, a shape of the aperture needs to a long and thin slit in the Y direction. The aperture having this long and thin slit shape is difficult to process, and the strength of the aperture becomes weak. Therefore, the anti-mechanical vibration performance of the aperture becomes weak.

In view of such issues of using the aperture, the RPLA **1** of the second example embodiment uses the prism **12** having an aperture function. Specifically, the prism **12** having the aperture function and the incidence face **11** and the exit face **13** are integrated as one integrated structure, with which precision of a relative position of the incidence face **11** and the prism **12** having aperture function can be enhanced. Further, by using the integrated structure, the strength can be enhanced, and the anti-mechanical vibration performance can be enhanced.

With reference to FIG. **7**, a description is given of the RPLA **1** employing the prism **12** having the aperture function. FIG. **7** is a schematic cross-sectional view of the RPLA **1** showing a light path of as similar to FIG. **2**. As shown in FIG. **7**, in the XZ plane passing a face top of one optical face of the incidence face **11**, a width of the incidence face **11** in the Z-axial direction is set as "Wi," and a width of the prism **12** in the Z-axial direction is set as "Wpi" in the same XZ plane.

If the width relationship is Wi≤Wpi, some of the light beam "a" coming from the light source may not pass though a route of the incidence face **11**→the prism **12**→the exit face **13** due to the relative position error of the incidence face **11**, the prism **12** and the exit face **13**, and the relative position error of the light source and the RPLA **1**.

For example, the light beam "b" that has passed the incidence face **11** and the prism **12** may pass a face other than the exit face **13**, and then reaches the imaging face, in which the light beam "b" becomes the ghost light.

In view of such issue, in the RPLA **1** of the second example embodiment, a configuration having a width relationship of Wi>Wpi is used. Specifically, in the XZ plane passing a face top of an optical face of the incidence face **11**, a width Wpi of the prism **12** in the Z direction is set smaller than a width Wi of optical face of the incidence face **11** in the Z direction. When the RPLA **1** satisfying this condition is used, only a part of the light passing through the incidence face **11** can enter the prism **12**.

In other words, some of the light beam "a" emitted from the light source and passing through the incidence face **11** is not entered to the prism **12**. The light beam "b" not entering the prism **12** does not go to the exit face **13** side (imaging face side), with which the light beam "b" does not become the ghost light. As above described, by adjusting a length of the incidence face **11** and a length of the prism **12** in the Z direction, the aperture function can be set to the prism **12**. With this configuration, even if the relative position error occurs to the incidence face **11**, the prism **12** and the exit face **13**, the light beam "b" not passing a normal route (incidence face **11**→prism **12**→exit face **13**) does not reach the imaging face, with which occurrence of ghost light can be suppressed.

If the pitch (lens pitch) of the incidence face **11** and the exit face **13** is same as the pitch of the prism **12**, as above described, the effect of the ghost light caused by a deviation of a position of the light on the prism lens array **120** in the Y direction becomes great. Therefore, the ghost light caused by other reason is not so prominent.

However, when the RPLA **1** of the second example embodiment is used, a brighter image can be focused, and the ghost light caused by a deviation of a position of the light on the prism lens array **120** in the Y direction can be reduced greatly. Therefore, the effect of the ghost light caused by the light beam "b" that reaches the imaging face without passing the normal route (incidence face **11**→prism **12**→exit face **13**) becomes prominent.

As to the RPLA **1** of the second example embodiment, the aperture function can be included to the prism **12**. Therefore, occurrence of prominent ghost light can be prevented, and brighter image can be formed effectively.

If the light source uses a light emitting diode (LED) and an organic electroluminescence (OEL), light emitted from LED and OEL becomes a light having broader light area. Therefore, a ratio of light not entering the incidence face of the imaging system becomes greater. If such light source (e.g., LED, OEL) is used, the ghost light may occur more likely. To suppress the effect of broader light coming from the light source, an aperture can be disposed at the incidence face side. However, it is very difficult to manufacture an aperture array matched to each incidence face of the imaging system with high precision. Therefore, if the RPLA **1** having the aperture function is used for the imaging system when the light source employs the LED and OEL, occurrence of ghost light can be suppressed effectively. The RPLA **1** having the aperture function is suitable as the imaging system when the light source uses a light having broader light area.

Third Example Embodiment of Imaging System

When the prism **12** having the aperture function is applied for the RPLA **1**, the aperture function can be set not only at the incidence face **11** side, but also at the exit face **13** side.

As shown in FIG. **7**, in the XZ plane passing a face top of an optical face of the exit face **13**, a width of the optical face in the exit face **13**, which is a width of the exit face **13** in the X-axial direction is set as "Wo", and a width of the prism **12** in the X-axial direction is set as "Wpo." By setting the width Wpo of the prism **12** in the X direction smaller than the width Wo of optical face in the exit face **13**, which means, by setting a configuration satisfying Wo>Wpo, the aperture function can be set to the exit face **13** side of the prism **12**.

With this configuration, even if the relative position error occurs to the incidence face **11**, the prism **12**, and the exit face **13**, occurrence of ghost light can be further suppressed effectively.

Fourth Example Embodiment of Imaging System

A description is given of an imaging system according to fourth example embodiment. Based on setting the size of the prism **12** in line with the above described RPLA **1**, a face (e.g., face S in FIG. **7**) connecting the prism **12** and the exit face **13** is set with a given angle. The light passing the incidence face **11** but not passing the prism **12** goes to the face S. With this configuration, the light that causes the ghost light exits outside the RPLA **1** from the face S.

In this configuration, for example, the face S is set parallel to the YZ-plane. Because the light not entering the prism **12** can exit outside the RPLA **1** from a face (e.g., face S) connecting the prism **12** and the exit face **13**, unnecessary light can be directed to a direction different from the imaging face, with which occurrence of ghost light can be suppressed.

Fifth Example Embodiment of Imaging System

A description is given of an imaging system according to fifth example embodiment. In relation to the RPLA **1** of the above described example embodiment, a configuration to exit the light from a face of the RPLA **1**, connecting the incidence face **11** and the prism **12**, can be configured with different settings.

As shown in FIG. **8**, in the XZ plane passing a face top of an optical face of the incidence face **11**, a direction from the incidence face **11** toward the prism **12** is set as a positive direction, and a direction from the prism **12** toward the exit face **13** is set as a positive direction. Further, an angle from the incidence face **11** toward the exit face **13** is set as a positive angle.

As shown in FIG. **8**, in the RPLA **1** of the fifth example embodiment, an angle θ1 defined by a side face **S1** connected to the incidence face **11**, which is one of side faces connected to the prism **12**, and a positive X-axial direction is set within a given value.

If the angle θ1 is set "0 deg≤θ1<90 deg," the light entering the incidence face **11** but not entering the prism **12** reflects at the side face **S1** and is directed to the imaging face direction (direction to the exit face **13** or +Z direction), and this light may cause the ghost light.

In the RPLA **1** of the fifth example embodiment, the angle θ1 defined by the side face **S1** and +X axis is set to satisfy a range of "−90 deg≤θ1≤0 deg" (condition 1). With this configuration, the light entering the incidence face **11** but not entering the prism **12** passes the side face **S1** or is reflected at the side face **S1** to a direction different from the exit face **13**. Because the light that may cause the ghost light can exit outside the RPLA **1**, occurrence of ghost light can be suppressed.

Sixth Example Embodiment of Imaging System

A description is given of an imaging system according to a sixth example embodiment. In relation to the RPLA **1** of the above described example embodiment, a configuration to exit the light outside the RPLA **1** from a face connecting the prism **12** and the exit face **13** can be configured with different settings.

As shown in FIG. **9**, in the XZ plane passing a face top of an optical face of the incidence face **11**, a direction from the incidence face **11** toward the prism **12** is set as a positive direction, and a direction from the prism **12** toward the exit face **13** is set as a positive direction. Further, an angle from the incidence face **11** toward the exit face **13** is set as a positive angle.

As shown in FIG. **9**, in the RPLA **1** of the sixth example embodiment, among side faces connected to the prism **12**, an angle Γ2 defined by a side face **S2** connected to the exit face **13**, which is one of side faces connected to the prism **12**, and a positive X-axial direction is set within a given value.

If the angle θ2 is set "0 deg≤θ2," the light entering the incidence face **11** but not entering the prism **12** reflects at the side face **S2** and is directed to the imaging face direction (direction to the exit face **13** or +Z direction), and this light may cause the ghost light.

In the RPLA **1** of the six example embodiment, the angle θ2 defined by the side face **S2** and +X axis is set to satisfy a range of "−90 deg≤θ2≤0 deg" (condition 2). With this configuration, the light entering the incidence face **11** but not entering the prism **12** does not enter the side face **S2**, with which occurrence of ghost light can be suppressed.

Seventh Example Embodiment of Imaging System

A description is given of an imaging system according to a seventh example embodiment. In relation to the RPLA **1** of the above described example embodiment, a configuration to exit the light outside the RPLA **1** from a face connecting the prism **12** and the exit face **13** can be configured with different settings.

A shown in FIG. **10**, in the XZ plane passing a face top of an optical face of the incidence face **11**, a direction from the incidence face **11** toward the prism **12** is set as a positive direction, and a direction from the prism **12** toward the exit face **13** is set as a positive direction. Further, an angle from the incidence face **11** toward the exit face **13** is set as a positive angle.

As shown in FIG. **10**, in the RPLA **1** of the seventh example embodiment, among side faces connected to the prism **12**, a side face **S3** connecting the prism **12** and the exit face **13** is set as one side face connected to the prism **12**. A normal line of the side face **S3** and a line parallel to the positive X direction axis intersect at one point. An angle θ3 defined by the normal line of the side face **S3** and the line parallel to the positive X direction axis is set within a given value.

If the angle θ3 is set "−90 deg≤θ3<40 deg," the light entering the incidence face **11** but not entering the prism **12** totally reflects at the side face **S3** and is directed to the imaging face direction (direction to the exit face **13** or +Z direction). Because the total reflection means 100% reflection theoretically, a light having greater intensity is directed to the imaging face direction. This light may cause the ghost light having greater intensity.

In the RPLA **1** of the seventh example embodiment, the angle θ3 defined by the side face **S3** and +X axis is set to satisfy a range of "−40 deg≤θ3<90 deg" (condition 3). With this configuration, the light entering the incidence face **11** but not entering the prism **12** passes the side face **S3** or is reflected at the side face **S3** to a direction different from the exit face **13**. Because the light that may cause the ghost light can exit outside the RPLA **1**, occurrence of ghost light can be suppressed.

Further, if the angle θ3 is set "−40 deg≤θ3<0 deg," some light may reflect at the side face **S3**, although a small light quantity, and is directed to the imaging face direction as a reflection light, and this reflection light may cause the ghost light. Therefore, the angle θ3 is preferably set "0 deg≤θ3<90 deg" (condition 4). With this configuration, the reflection light reflected at the side face **S3** can be directed to a direction different from the imaging face direction, with which occurrence of ghost light can be suppressed.

(Writing Head)

A description is given of a writing head according to an example embodiment. FIG. **11** is a cross-sectional view of a writing head **30** according to an example embodiment. As shown in FIG. **11**, the writing head **30** includes, for example, the RPLA **1**, a light source **31** and a board **32**. The RPLA **1** is an example of the above described imaging system. The light source **31** includes a plurality of light sources arranged in at least one line pattern in an arrangement direction (Y direction) of the incidence face array **110** of the RPLA **1**. The board **32** retains the light source **31** at a given position.

As to the writing head **30**, the light beam "a" emitted from the light source **31** enters the incidence face array **110**, and is then reflected by the prism array **120**, and is focused as an image on an imaging face D via the exit face array **130**.

Because the writing head **30** includes above described RPLA **1** as the imaging system, the ghost light does not reach the imaging face D, and a brighter image can be focused.

(Image Forming Apparatus)

A description is given of an image forming apparatus according to an example embodiment. FIG. **12** is a schematic configuration of an image forming apparatus **50** according to an example embodiment, which can form multi-color images. As shown in FIG. **12**, the image forming apparatus **50** includes, for example, a photoconductor **51** (**51**Y, **51**M, **51**C, **51**K) used as an image bearing member, a charger **52** (**52**Y, **52**M, **52**C, **52**K), the writing head **30** (**30**Y, **30**M, **30**C, **30**K) used as an optical writing unit, a development unit **54** (**54**Y, **54**M, **54**C, **54**K), a cleaning unit **55** (**55**Y, **55**M, **55**C, **55**K), a transfer charger **56** (**56**Y, **56**M, **56**C, **56**K), a transfer belt **57**, and a fusing unit **58**. Y, M, C and K represent color of image such as yellow, magenta, cyan and black respectively.

A surface of the photoconductor **51** is used as the imaging face, to which an image is focused by the writing head **30** according to the above described example embodiment.

In the image forming apparatus **50**, the photoconductors **51**Y, **51**M, **51**C and **51**K rotates in a direction shown by arrows in FIG. **12**. The chargers **52**Y, **52**M, **52**C, **52**K, the development units **54**Y, **54**M, **54**C, **54**K, the transfer chargers **56**Y, **56**M, **56**C, **56**K, and the cleaning units **55**Y, **55**M, **55**C, **55**K are disposed along the respective photoconductors **51**Y, **51**M, **51**C and **51**K in this rotation direction.

Each of the chargers **52**Y, **52**M, **52**C, **52**K is a charger to charge the surface of the photoconductor **51** uniformly. Upon charging the photoconductors **51**Y, **51**M, **51**C, **51**K using the chargers **52**Y, **52**M, **52**C, **52**K, the photoconductors **51**Y, **51**M, **51**C, **51**K are exposed by an exposure device such as the writing heads **30**Y, **30**M, **30**C, **30**K according to an example embodiment to form an electrostatic latent image.

Each of the development units **54**Y, **54**M, **54**C, **54**K develops the electrostatic latent image as toner images on the photoconductors **51**Y, **51**M, **51**C, **51**K. Further, each of the transfer chargers **56**Y, **56**M, **56**C, **56**K is used as a transfer unit to transfer each of toner images onto the transfer belt **57**, with which each of toner images is superimposed on the transfer belt **57**. Then, the superimposed toner images are transferred on a recording medium such as a recording sheet, and the fusing unit **58** fuses an image on the recording sheet.

As above described, the writing head **30** can devise enhanced light use efficiency and can suppresses occurrence of ghost light. Therefore, the image forming apparatus **50** can output an image without abnormal image while reducing power consumption.

In the above described imaging system, light use efficiency can be enhanced while suppressing the occurrence of ghost light.

Numerous additional modifications and variations are possible in light of the above teachings. It is therefore to be understood that, within the scope of the appended claims, the disclosure of the present invention may be practiced otherwise than as specifically described herein. For example, elements and/or features of different examples and illustrative embodiments may be combined each other and/or substituted for each other within the scope of this disclosure and appended claims.

What is claimed is:

1. An imaging system, comprising:

a plurality of incidence faces composed of a plurality of optical faces through which light enters and having an image focusing function;

a plurality of prisms; and

a plurality of exit faces,

wherein the plurality of incidence faces is arranged with a first pitch along a first axial direction, the plurality of prisms is arranged with a second pitch along the first axial direction, the plurality of the exit faces is arranged with a third pitch along the first axial direction,

wherein the first axial direction is set as a Y direction,

wherein a normal line direction of a face top of an optical face of the incidence face in a plane perpendicular to the first axial direction is set as a X direction,

wherein a direction perpendicular to the Y direction and the X direction is set as a Z direction, and

wherein in a XZ cross-section plane, a width of the prism in the Z direction is smaller than a width of the optical face of the incidence face in the Z direction.

2. The imaging system of claim **1**, wherein the second pitch is shorter than the first pitch and the third pitch.

3. The imaging system of claim **1**, wherein in the XZ cross-section plane, a width of the prism in the X direction is smaller than a width of optical face of the exit face in the X direction.

4. The imaging system of claim **1**, wherein a part of light emitted from a point light source and passing the incidence face does not enter the prism.

5. The imaging system of claim **4**, wherein the light not entering the prism exits outside the imaging system from a part of a face connecting the prism and the exit face.

6. The imaging system of claim **5**, wherein in the XZ cross-section plane, the X direction from the incidence face toward the prism is set as a positive direction, the Z direction from the prism toward the exit face is set as a positive direction, and an angle from the X direction to the Z direction is set as a positive angle,

wherein among side faces connected to the prism, an angle $\theta 1$ defined by a side face connected to the incidence face and the positive X direction satisfies a first condition: $-90\ \text{deg} \le \theta 1 < 0\ \text{deg}$.

7. The imaging system of claim **5**, wherein in the XZ cross-section plane, the X direction from the incidence face toward the prism is set as a positive direction, the Z direction from the prism toward the exit face is set as a a positive direction, and an angle from the X direction to the Z direction is set as a positive angle,

wherein among side faces connected to the prism, an angle $\theta 2$ defined by a side face connected to the exit face and the positive X direction satisfies a second condition: $-90\ \text{deg} \le \theta 2 < 0\ \text{deg}$.

8. The imaging system of claim **5**, wherein in the XZ cross-section plane, the X direction from the incidence face toward the prism is set as a positive direction, the Z direction from the prism toward the exit face is set as a positive direction, and an angle from the X direction to the Z direction is set as a positive angle,

wherein a light path of light passing through a portion of the incidence face but not entering the prism and entering a side face connecting the prism and the exit face,

wherein a normal line of the side face, connecting the prism and the exit face, and a line parallel to the positive X direction axis intersect at one point, wherein an angle $\theta 3$ defined by the normal line of the side face, connecting the prism and the exit face, and the line parallel to the positive X direction axis satisfies a third condition: $-40\ \text{deg} \le \theta 3 < 90\ \text{deg}$.

9. The imaging system of claim **8**, wherein the angle $\theta 3$ further satisfies a fourth condition: $0\ \text{deg} < \theta 3 < 90\ \text{deg}$.

10. The imaging system of claim **1**, wherein light emitted from a light source enters a plurality of optical faces of the incidence face, exits from the plurality of optical faces of the exit face, and is then focused at a substantially one point.

11. The imaging system of claim **1**, wherein one optical face of the incidence face and one optical face of the exit face existing at the same position with respect to the first axial direction are paired,

wherein a virtual plane connects an end of the paired optical face of the incidence face in the first axial direction and an end of the paired optical face of the exit face in the first axial direction,

wherein among light emitted from a point light source and entering the paired optical face of the incidence face, light passing through the virtual plane is reflected by the prism, and then passing through the virtual plane again, and then going to the paired optical face of the exit face.

12. A writing head, comprising:

a light source array having a plurality of light sources arranged in at least one line pattern;

a board to retain the light source array; and

the imaging system of claim **1** to which light from the light source array enters.

13. An image forming apparatus, comprising:

the writing head of claim **12**;

an image bearing member;

a development unit to develop an electrostatic latent image formed on the image bearing member as a toner image by the writing head using each color of toner; and

a transfer unit to transfer the toner image developed on the image bearing member to a recording medium.

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